Amendments to the Drawings:

The attached sheets of formal drawings includes Figures 1-4. These sheets replaces the original informal drawings Figures 1-4. Formals drawings are submitted herewith under separate Letter to the Draftsperson. Approval by the Examiner is respectfully requested.

Attachment: Replacement Sheets Figures 1-4

REMARKS

Claims 1-26 and 45-54 are pending in this application. Claims 1-26 and 45-54 stand rejected. Claims 19 and 47 have been cancelled. Claims 1-3, 6-8, 13-15, 20-21, 26, 45, 48-49, and 53-54 have been amended. Claims 1-18, 20-26, 45-46, and 48-54 remain in the application. Formal drawings are submitted herewith under separate Letter to the Draftsperson.

Objections

Claim 25 stands objected to. The office action states: "Claim 25 should have been amended in the same manner as Claim 13." This objection is understood to be intended to refer to Claim 26 rather than Claim 25. Claims 13 and 26 have both been further amended so as to overcome the rejection.

Claims 45 and 54 stand objected to on a grammatical matter. Claims 45 and 54 have been amended resolving this.

Rejections under 35 U.S.C. Section 112

Claims 6, 19, 45, and 54 stand rejected under 35. U.S.C. 112 in relation to usage of the term "objective function". Claim 6 was amended changing that language. Claim 19 was cancelled. Claims 45 and 54 were amended as suggested in the rejection.

Rejections under 35 U.S.C. Section 103

Claims 1-9, 11-22, and 24-26 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over [Snyder90] (W. Snyder et al., *Optimal Thresholding-A New Approach,* Pattern Recognition Letters 11, 1990), in view of [Neves96] (N. Neves et al., *A Study of a Non-Linear Optimization Problem Using a Distributed Genetic Algorithm,* International Conference on Parallel Processing, 1996). The rejection states:

> '*The following is in regard to Claims 1 and 14.* The Applicant has amended Claim 1 so as to incorporate limitations from Claim 2. The original language of Claim 2, therefore, encompasses all subject matter currently claimed in the amended Claim 1, with the exception of the limitation of "digital image data".
>
> 'Recall from the previous Office Action (paragraphs 35-38 on pages 11-13; see also paragraph 23 on pages 8-9) and the discussion above, that Claim 2 was originally rejected under U.S.C. § 103(a) as being unpatentable over [Snyder90], in view of [Neves96]. That discussion

made no assumptions about the data being modeled and, therefore, would apply generally to all types of data, including digital image data. Furthermore, the methodology disclosed in [Snyder90] is clearly directed to digital image data (see, for example, paragraphs 1 and 4 in Section 1 of [Snyder90]). The rejection of amended Claim 1, therefore, follows directly from the rejection of original Claim 2 presented in the previous Office Action. For the sake of brevity, that discussion will not be repeated here. Please refer to paragraph 23 on pages 8-9 and paragraphs 35-38 on pages 11-13 of the previous Office Action.'

The previous rejection (mailed March 16, 2004) stated as to then Claim 2:

"With regard to claim 2, by virtue of the genetic algorithm used, Neves et al. teach a method of non-linear least squares fitting comprising:

"The step of altering said total number of functions. Refer to section 2, BACKGROUND. The discussion therein relates to the theoretical basis of genetic algorithms. As discussed there, (last paragraph of Neves et al.'s BACKGROUND, genetic algorithms begin with an initial population New individuals (states in the search space) are introduced and individuals of the current or prior generations are eliminated based on their fitness. It should be understood that, with regard to the methodology proposed in section 4 of Neves et al., the search space is the space of all potential parameter sets *X*. Each of these parameter sets corresponds to a function *f(t,X)* in a bijective manner. Therefore, as the number of parameter set candidates changes through successive generations, so to does the total number of corresponding functions.

"Repeating:

"Generating a modeling function based on said plurality of function parameters.

"Determining an objective function that measures the fitting error between said modeling function and the data.

"Comparing said fitting error to stopping criteria to determine if said stopping criteria is satisfied.

if, at the comparing step, the fitting error does not satisfy the stopping criteria. Again, this is inherent to the genetic algorithm of Neves et al. During each generation of the algorithm, a parameter sets X are generated and the functions $f(t,X)$ evaluated. The objective function (e.g. 34.1 above) is evaluated (where it is clear that 34.1 measures the fitting error). The algorithm continues until it converges to a global optimum (see section 2, BACKGROUND, of Neves et al.).

"Note from the preceding discussion that both Neves et al. and Snyder attempt to solve the same problem, that is, minimizing the sum of the squared errors between the modeling function and the input data. It would be well within the capabilities of one of ordinary skill in the art to utilize a genetic algorithm of Neves et al. to find the global minimum of the objective function H in the fitting technique of Snyder et al., particularly since Neves et al. have demonstrated the use the algorithm in minimizing the sum of the squared errors between the modeling function and the input data. (Note the objective function of Neves et al. and Snyder et al. are the same). The advantages of applying genetic algorithms to optimization problems, involving the minimization of the sum of the squared errors between the modeling function and the input data, are, among other things, that these algorithms converge, unsupervised, to a *global* minimum, easily accommodate a variety of constraints, are self-adaptive (in the sense that bad solutions are eliminated without intervention) and are relatively insensitive to initial parameters such as population size, when compared to other optimization methods. Given these advantages of genetic algorithms and their demonstrated applicability to optimization problems involving the minimization of the sum of the squared errors between the modeling function and the input data, it would have been obvious to one of ordinary skill in the art, at the time of the applicant's claimed invention, to use the genetic algorithm of Neves et al. to minimize the objective function (fitting error) of the fitting

technique taught by Snyder et al. In so doing, one would obtain a method of fitting that conforms to all limitations of claim 2."

Claim 1 states:

1. A method of fitting a plurality of sub-population functions to digital image data, comprising the steps of:

defining a plurality of collections, each of said collections having a plurality of functions according to a plurality of function parameters and a total number of functions;

determining an objective function for the fitting error between each of said collections and the data;

comparing each said fitting error to stopping criteria to determine if said stopping criteria is satisfied;

if, at said comparing step, said stopping criteria is not satisfied, then altering said plurality of function parameters and said total number of functions in randomly selected said collections, and

following said altering step, repeating said determining, comparing, and altering steps.

The amended language of Claim 1 is supported by the application as filed, notably the original claims and at page 22, line 28 to page 23, line 5; page 23, line 24 to page 24, line 3; and page 24, lines 12-16.

The rejection indicates that Synder et al. does not teach altering the total number of functions and cites Neves et al. for that feature. The cited portion of the previous rejection states regarding Neves et al.:

"Each of these parameter sets corresponds to a function *f(t,X)* in a bijective manner. Therefore, as the number of parameter set candidates changes through successive generations, so to does the total number of corresponding functions."

The total number of functions is different in amended Claim 1, in that the total number of functions is in a particular collection and not a grand total in all collections. Claim 1 requires defining <u>a plurality of collections, each having a plurality of functions</u> according to a plurality of function parameters <u>and a total number of functions</u>. Fitting error is determined for each collection and each fitting error is compared to stopping criteria. If the stopping criteria is not

satisfied, then the plurality of function parameters <u>and total number of functions are altered in randomly selected collections</u>.

Neves et al. teaches use of a parameter set, function *f(t,X)*, which has a fixed number of functions:

> "The particular function used in the experiment has four polynomials and two exponentials, which correspond to eight unknowns, and consequently to an eight-dimension search space." (Neves et al., page II-31, left column, second paragraph of section 4)

The combination of Neves et al. with Snyder et al. does not change this teaching. (See the discussion of dimension *d* search space in Snyder et al., page 805, left column, second paragraph of section 3; page 807, right column, first paragraph of section 4)

In Claim 1, the altering of the plurality of function parameters and the total number of functions is in randomly selected collections. The rejection describes a change in number of parameters in successive generations, but that change is described in Neves et al. as not being random:

> "As this process continues, the population converges". (Neves et al., page II-30, left column, partial paragraph ending section 2; Snyder et al., as noted above, is silent on this.)

Claims 2-9 and 11-13 are allowable as depending from Claim 1 and as follows.

Claims 2-3, 6-7, and 13 were amended to track the language of Claim 1. Claim 6 was also amended to depend from Claim 3.

Claim 8 states:

> 8. The method of Claim 7 wherein said evolving includes crossover followed by mutation.

Amended Claim 8 is supported by the application as filed, notably the original claims and at page 24, lines 9-10.

Amended Claim 14 is supported and allowable on the same basis as Claim 1.

Claims 15-22 and 24-26 are allowable as depending from Claim 14 and as follows.

Claims 15, 20-21, and 26 were amended to track the language of Claim 14.

Claim 21 was amended in the same manner as Claim 8.

Claims 10 and 23 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over [Snyder90], in view of [Neves96], in further view of [Levine99] (D. Levine, Statistics For Managers Using Microsoft Excel: Chapter 14 - Multiple Regression Models, Prentice-Hall, 1999).

Claims 10 and 23 are allowable as depending from Claims 1 and 14, respectively.

> Claims 45-50 and 52-54 are rejected under 35 U.S.C. § 103(a) as being unpatentable over [Snyder90], in view of [Neves96], in further view of [Mitchell94] (M. Mitchell and S. Forrest, *Genetic Algorithms and Artificial Life*, Artificial Life Vol. 1(3), 1994).

Claim 45 states:

> 45. A method of specifying thresholds for segmenting a digital image, comprising the steps of:
>
> producing a histogram of the image, the histogram having histogram data;
>
> defining a collection of mixture models, each said mixture model being a combination of a plurality of subpopulations; wherein each subpopulation is a function defined according to a plurality of function parameters;
>
> defining a generation of chromosomes, each said chromosome being a vector encoding a respective one of the mixture models wherein the elements of the vector encode the respective plurality of function parameters of the plurality of subpopulations;
>
> for each chromosome in the generation, performing the following steps:
>
> > determining the fitting error between the mixture model defined by the chromosome and the histogram data;
> >
> > determining a measure of the relative contributions of the individual sub-populations defined by the chromosome; and
> >
> > determining a fitness value based on said fitting error and said measure of relative contributions;
>
> comparing said fitness values to stopping criteria;

altering said plurality of function parameters and said total number of functions in randomly selected chromosomes of said generation to define a next generation of chromosomes, if none of said fitness values satisfies said stopping criteria; and

repeating said performing, comparing, and altering steps on said next generation of chromosomes, if none of said fitness values satisfies said stopping criteria; and

specifying at least a first threshold value delineating said sub-populations in a respective said mixture model, if at least one of said fitness values satisfies said stopping criteria.

Claim 45 is supported and allowable on the same grounds as Claim 1 (The addition of Mitchell as a reference does not alter the teachings of the other references discussed in relation to Claim 1.)

Claims 46-50 and 52-53 are allowable as depending from Claim 45 and as follows.

Claims 48-49 and 53 were amended to track the language of Claim 45.

Claim 49 is supported on the same grounds as Claim 8.

Claims 51 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over [Snyder90], [Neves96], and [Mitchell94], in further view of [Levine99]. Claim 51 is allowable as depending from Claim 45.

Amended Claim 54 is supported and allowable on the same basis as Claim 1.

It is believed that these changes now make the claims clear and definite and, if there are any problems with these changes, Applicants' attorney would appreciate a telephone call.

In view of the foregoing, it is believed none of the references, taken singly or in combination, disclose the claimed invention. Accordingly, this application is believed to be in condition for allowance, the notice of which is respectfully requested.

Respectfully submitted,

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Enclosures: Replacement Figures 1-4
Letter to the Draftsperson
Copies of Formal Drawings

If the Examiner is unable to reach the Applicant(s) Attorney at the telephone number provided, the Examiner is requested to communicate with Eastman Kodak Company Patent Operations at (585) 477-4656.